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# Observation of a cross-subfamily male-male mating attempt of grasshoppers in Kazakhstan (Orthoptera, Acrididae)

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## Abstract

Same-sex and interspecific sexual behavior have been documented in arthropods, but records remain very scarce. We report a mating attempt of a male *Dociostaurus kraussi* (Ingenitzky, 1897) (Gomphocerinae) and a male of *Oedaleus decorus* (Germar, 1825) (Oedipodinae), both grasshoppers (Orthoptera: Acrididae), from the region of the Dzungarian Alatau Mountains in Kazakhstan. A Disc3D scan showed that the cerci of the *D. kraussi* male clearly connect to the external genitalia of the *O. decorus* male, but we could not ascertain if the genitalia were inserted or if any sperm was transferred. We consider erroneous recognition the most likely explanation but discuss other potential reasons, concluding that much remains to be learned about the highly complex reproductive behavior of acridid grasshoppers.

## Key Words

*Dociostaurus*, Dzungarian Alatau, interspecific sexual behavior, Kazakhstan, *Oedaleus*, same-sex sexual behavior

## Introduction

Both same-sex sexual (or homosexual) behavior and interspecific sexual behavior have been documented in a variety of animal groups, including many arthropods (Bagemihl 1999). However, most of these records were the results of chance observations rather than of targeted scientific study. Consequently, it remains poorly understood if there is any adaptive benefit to these types of behavior, and if so, which (Scharf and Martin 2013). One potential explanation is that in environments of strong sexual male-male competition and imperfect sensory recognition mechanisms, mating with another male may be less costly than rejecting a female (Thornhill and Alcock 1983). This has been suggested, e.g., based on studies on Coleoptera and Diptera, some of which seem to rely on characters as simple as body size to distinguish females from males. Many species of Orthoptera, however, have evolved highly complex mate recognition systems in which both sexes employ a combination of acoustic, optical, and chemical signals to select conspecifics of the opposite sex during extensive courtship (Vedenina and Mugue 2011). While chemical signals may be misleading, e.g., in case of males carrying female pheromones from earlier matings, other types of signals can mostly be considered reliable. As a result, while hybrids of pairs of closely related species are known to occur in nature under certain conditions, mate choice has been found to be highly efficient (Gottsberger and Mayer 2007).

## Methods

In the morning of June 26, 2023, we captured Orthoptera in a semi-desert locality (45.7957°N, 81.6379°E; ca. 655 m a.s.l) in the Northern foothills of the Dzungarian Alatau Mountains near Lake Alaqol, 10 km south of

Koktuma, in the Jetisu Region of Kazakhstan. We transported around five to six live individuals per container in a total of seven containers for later processing at the camp. One container included, among others, a male of *Dociostaurus kraussi* (Ingenitzky, 1897) (Gomphocerinae; field number SOH_1561) and a male of *Oedaleus decorus* (Germar, 1825) (Oedipodinae; SOH_1560) (Fig. 1). Upon inspecting the container in the afternoon, we found that *D. kraussi* had mounted *O. decorus* and connected its cerci to the other male's genitalia. This position persisted into the evening, and the individuals did not let go when removed from the container and when subsequently immersed into 80% ethanol for preservation. We did not detect any resistance behavior from the mounted *O. decorus* male. Later, we pinned and dried the mated couple and 3D imaged it using a Disc3D insect scanner at the Leibniz Institute for the Analysis of Biodiversity Change (LIB) Hamburg (Ströbel et al. 2018). The scan shows that the cerci of the *D. kraussi* male clearly connect to the external genitalia of the *O. decorus* male, but it remains unclear if the genitalia were actually inserted or if any sperm was transferred (Fig. 2, Suppl. material 1: fig. S1). The specimens are currently stored at the University of Zurich, Switzerland. We report due diligence in following the regulations of the Nagoya protocol, as per contacting the National Focal Point of Kazakhstan. No other research and export permits were required.

## Results and discussion

While no courtship behaviour has been demonstrated for *O. decorus*, *D. kraussi* are known to generate very simple songs. Like other Dociostaurini, *D. kraussi* uses a so-called wandering mating strategy (Helversen and Helversen 1994). Both sexes wander around their territories. Males periodically generate very simple calling songs (Savitsky 2000), but females are not known to produce any answers in this species. This suggests that males will try to copulate without waiting for an acoustic signal from females. From *O. decorus*, on the other hand, no acoustic communication is known at all. Under natural conditions, mating attempts between *D. kraussi* and *O. decorus* should still be extremely rare because of the chemical mating barriers present in most grasshopper species. It is therefore likely that the observed mating event is an artifact of captivity and possibly stress, where most mate recognition signals were inhibited. The copulation attempt of the *D. kraussi* male may have been stimulated by the strong similarity in body size of *O. decorus* males (18–31 mm) and *D. kraussi* females (19.3–31.5 mm). Nevertheless, the occurrence of this cross-subfamily male-male mating attempt and the fact that the mounting male remained mounted and with genitalia attached without letting go indicates that such events may occur in nature as well.


**Figure 1. A.** Male of *Dociostaurus kraussi* (Gomphocerinae; field number SOH_1561). **B.** Male of *Oedaleus decorus*. **C.** The sampling locality in the Jetisu Region of Kazakhstan. Photos: **A, B.** O. Hawlitschek, **C.** N. Sevastianov.

**Figure 2.** Disc3D scan screen capture of a male *Dociostaurus kraussi* (Gomphocerinae; field number SOH_1561) mounting and attempting to copulate with a male *Oedaleus decorus* (Oedipodinae; SOH_1560). See Suppl. material 1: fig. S1 for a complete movable scan. Scan: J.-H. Pamin.

Under the conditions of captivity, we consider erroneous mate recognition the most likely explanation for the observed behavior. This, in turn, may be facilitated by the inclination of males to mount and attempt to mate in case of doubt due to lower cost, as described above. However, there may also be other potential benefits to the observed behavior. In their discussion on reproductive interference, Gröning and Hochkirch (2008) listed several cases in which insects used behavior that could reduce the reproductive success of conspecifics and other species. In Orthoptera, most documented cases consisted of signal jamming, i.e., individuals degrading the signals of other individuals (conspecifics or heterospecifics) by emitting signals of their own and thus complicating mate recognition. However, intraspecific male-male sexual behavior has been discussed as potential interference with the reproductive success of conspecific males. Between syntopic species competing for similar resources, interspecific same-sex mating behavior may interfere with the reproduction of the competitor and thus lower intraspecific competition for the offspring generation. To the male initiating this behavior, the cost is related to its inability to engage in sexual behavior that would lead to reproductive success at the same time. However, we suggest that the benefits might still outweigh the costs in case the male has already spent much of its sperm or if the density of females available for mating is low, in which case males could ‘block’ the males of a competing species while waiting for a conspecific mate. Such behavior may be beneficial to the individual of the species encountering a comparatively lower density of conspecific females, no matter whether it is the ‘active’ male initiating the mount or the ‘passive’ male allowing the mount.

Our observation is another example for the highly complex reproductive behavior of acridid grasshoppers. While many studies have already been conducted in this field, much certainly remains to be discovered.

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## Supplementary material 1

### 3D-scan of mating attempt of *Dociostaurus kraussi* and *Oedaleus decorus*

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Data type: pdf

Explanation note: A male of *Dociostaurus kraussi* (Gomphocerinae) mounting a male of *Oedaleus decorus* (Oedipodinae) in a suspected mating attempt. The cerci of the *D. kraussi* male connect to the external genitalia of the *O. decorus* male. 3D image created with a Disc3D insect scanner at the LIB Hamburg. Open pdf in Adobe pdf viewer and click to rotate.



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